

DOI:

Chunhui Zhang Zhen Zhang. The State Grid Corporation of China With the American General Electric Corporation (GE) Review of the technical negotiations for the smart electricity meter joint venture project [J]. \*\*\*\*, \*\*\*\*, \*\*, (\*\*): 00-00

## The State Grid Corporation of China With the American General Electric Corporation (GE) Review of the technical negotiations for the smart electricity meter joint venture project

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**Abstract:** Introduces the initial objectives of GE smart meter joint venture jointly launched by State Grid Corporation, GE), Luneng Group and China Electric Power Research Institute, including the joint venture party, strategy, objectives and project progress. In addition, the GE Smart Power Technology Exchange meeting held by State Grid Corporation in China Power Research Institute on July 1, 2009. The participants included leaders and experts of State Grid Corporation, China Power Research Institute, Luneng Group Company and GE Company. During the meeting, GE introduced its general situation, the technical status of smart meters and the application of WiMax wireless communication technology. The participants had in-depth exchanges on the technical issues of smart meters and raised questions that need further supplementary explanation. The GE smart Meter joint venture project is launched to build one of the top smart meter companies in the world. The technical cooperation between State Grid Corporation and General Electric Corporation (GE) of the United States is of special significance in the field of measurement. The author, as a historical witness and a participant in the technical negotiations, it is necessary to record this period of history.

**Key words:** State Grid Corporation general Electric Corporation smart meter

### 0 foreword

On May 21, 2009, State Grid Corporation of China released the 2009 (2009- -2020).

Prior to this, state Grid organized visits to European and American countries to investigate the construction of smart meters and advanced measuring infrastructure (AMI).

In June 2009, State Grid Corporation of China launched a GE smart meter joint venture project between Luneng Group Corporation, China Electricity Research Institute and GE Corporation of the United States. The author of this article is employed as the general technical consultant of the joint venture project, Luneng Fang.

### 1. Initial target of GE Smart Meter joint venture project

On June 17, 2009, Luneng Holding Group Company convened a meeting of GE Smart meter Joint Venture project, and introduced the preliminary plan of GE Smart meter joint venture project:

1) Joint venture parties: Luneng Group Company, China Electric Power Research Institute, GE Company

2) Strategy: Luneng Holdings, privatized operation and state Grid market

3) Objective: To build itself into one of the top several smart electricity meter enterprises in the world

4) Project work progress

- -Communicate with GE technicians by the end of June 2009

- -On July 20, the State Grid issued requirements

for the standards, functions and technologies of smart electricity meters

-At the end of July, the GE smart meter test was completed

- -Before August 31, the two parties will comprehensively evaluate the screening results of domestic electricity meter enterprises and conduct cooperation negotiations

- -By September 30, GE has converted the US electronic electricity meter standard to the IEC standard

- -On September 30, the two parties jointly completed the feasibility report of the GE Smart Meter joint venture project.

## **2. Summary of GE Smart Meter Technology communication Meeting**

On July 1, 2009, State Grid held a GE Smart Power technology exchange meeting in China Electric Research Institute.

Delegates to the meeting:

· State Grid Corporation: Head of the metering department

· China Institute of Electric Power Research: 9 leaders and experts

· Luneng Group Company: 6 company leaders and experts. Among them, the author of this article, Shandong Institute of Electricity Wang Yunquan attended the meeting

· GE Company: 6 company leaders and experts.  
meeting summary:

1) GE, the company introduces GE Energy company overview and GE smart meter technology status

GE Energy Group is headquartered in Alexandria, The Group's business involves the water, electricity, gas and other fields, Many years of experience in electricity meter operation; GE's electricity meter products are mainly based on ANSI standards, Since 2007, In 2009, the third generation of smart meters based on ANSI standard was born; At present, GE smart meter communication is mainly based on WiMax wireless communication technology, In addition to the conventional functions of electricity meters, such as electric energy measurement, remote control and tOU electricity price, The function of GE

smart meter is also mainly reflected in the Internet router function of the meter and the function of reading the water and gas meter. GE company shows two smart meters based on ANSI standard, and for GE company I- -210C + and KV2c two meters briefly introduced the characteristics, the two meters are based on ANSI standard design, compared with IEC standard its difference is mainly reflected in the mechanical structure, precision requirements, rated current, data structure, clock accuracy, etc.

GE experts also highlighted the application of GE smart meter to WiMax wireless broadband communication technology, which meets the requirements of high-speed two-way communication. WiMax The network system is mainly constructed and operated by the local telecommunication department. GE smart meter instWiMax module designed by the third party and operates according to the rules set by the power supply company. Currently, WiMax wireless communication is not allowed to be used in China, but the application of GPRS, 3G and other technologies can be tried.

### **2) Communication of technical issues**

China Electric Research Institute and Luneng Group Corporation communicated with GE on smart meters, mainly involving the following issues:

- -The GE smart electricity meter failure rate problem

The failure rate of GE smart meter in 1-2 years is 0.1- -0.2%. GE believes that the failure rate is normal, and the meter is only sampled in the United States;

- -The number, scope and cost of the current application of GE smart meters

GE smart meters currently have two trials in Australia and the United States, running 4,000 smart meters; GE smart meters currently cost around \$200 / meter, and GE designs and produces around 1 million PLC and RF based meters for around \$150.

- -Prepaid standards and data security solutions

Since power users in the North American market rarely apply the prepaid system, GE smart meter prepaid has no reference standard, and data and information security mainly depends on the security of communication channel; for example, switch control

only relies on password control;

At present, GE smart meter prepaid mode mainly relies on real-time two-way communication system for remote prepaid.

-Is there a special multi-function ANSI standard?

At present, there is no special multi-function table standard, and the multi-function table design only refers to other standards.

-What are the advantages of ANSI standards compared with IEC standards?

GE believes that the ANSI standard has a plug-in structure that makes it easier to install, while the ANSI electricity meters are more accurate, with most smart meters reaching 0.2 levels.

-Benefit analysis of GE smart meters based on the North American market

GE's North American plant produced about 2 million to 3 million units in 2008 and about 500,000 units in the Philippines. There is no specific benefit analysis report yet.

-GE Smart electricity meter smart features

High-speed two-way communication can be used as Internet router to meet Internet requirements; built-in switch control is up to 320A; water meter and gas meter can be read.

3) Issues need to be supplemented by GE

— Type of faults found in GE smart meter operation

-The advantages and disadvantages of ANSI standard compared with IEC standard

-How accurate is the GE smart meter at the 0.01 power factor case?

-List of proprietary technologies and patent application schedules used (excluding structure) in all electricity meters of GE Company (except mechanical meters);

-What is the power consumption of GE smart meters in each communication mode?

-Harmonic collection method of GE smart electricity meters?

-GE provides the product content and cooperation steps for the upcoming cooperation;

-List the detailed functions of GE smart meters, and attach the corresponding standard number for

reference

-Advantages and disadvantages of GE smart meters compared with other enterprise electricity meters

-GE shall provide the testing sample table, testing system and testing methods as soon as possible.

### 3 , GE: Design description of I- -210 + C single-phase smart meter (translation)

I- -210 + C specification

1 ) The meter performance meets or exceeds the ANSI standard: C12.1, C12.10, C12.18, C12.19, C12.20 and C37.90.1

(Note: The ANSI C12 series of standards cover the communication protocols for electrical metering equipment and electricity meters.

C12.1---Electrical metering specifications for electricity meters

C12.10- -Electromechanical electricity meter

Protocol specification for the C12.18---ANSI 2-type optical interface

C12.19---Utilities industrial terminal equipment data sheet

C12.20---0.2 and 0.5 accuracy grade electricity meters

C37.90.1---Test of protective appliances and electrical systems)

2 ) Scope of work

---Voltage: 120 / 240V + / -20%

---Temperature: -40°C All up to + 85°C

---Typical starting watt number: ≤5W

---Typical watt loss: 0.7W

---Typical accuracy: within + / - 0.2%

---Design life: 15 years.

3 ) I- -210 + C record selection

— kWh records (normalized per meter)

· Delivered only

· Receive only

· Send out + receive

· Send out- -receive

-kVarh reactive power record (K2 software switch)

· Only lag behind

- Only ahead of time
- Lag + advance
- Lag- -ahead
  - kVAh (vector view) record (K2 software switch required)
  - Minimum, maximum, average voltage record calculated by the RMS algorithm (Q2 software switch required)
  - Sag (statistics and amplitude) (voltage drop) / Swell (voltage rise) record (V2 software switch)
- 4 ) I- -210 + C record selection
  - Time-sharing application record (T2 software switch is required)
    - 4 rates (grades), applied to each total addition and demand value record
    - 2 collections of recording data, such as outgoing kWh, and receiving kWh are recorded in each rate (A, B, C, D)
    - 4 seasons, with 3 typical days and 1 holiday per season
    - 80 switch operations
    - 50 programming dates (no recurring, fixed recurring and floating recurring dates supported)
    - 2 options for backup (power) retention time in interrupted situations
    - A 1 uses the same battery as KV2c (meter), with a 1-year carrying period
    - A 2 uses rechargeable ultracapacitors to provide an 8h carrying period.
    - Load curve / interval record (R2 software switch required)
      - The meter can store data for 1,2,3 or 4 channels
      - With a strong memory selection, it can store 4-channel data from 5 minutes interval to 35 days.
    - Requirement calculation (N2 software switch)
      - Select any two quantities:
        - Square demand
        - Rolling demand
        - Heat demand
        - Maximum demand
        - Accumulation demand
        - Continuous accumulation (demand)
- 5 ) I- -210 + C record selection and diagnosis
  - Event deposit (E2 software switch required)

- Record up to 200 events
  - Mark date and time mark when the T2 switch is installed
- Applicable events
  - warn
  - Power off and power up
  - Read and write the meter program
  - Replacement of demand
  - Self-reading
  - Test mode input
  - Test mode output
  - Real-time price activation
  - Real-time price is invalid
  - I- -210 + C warning
    - Low-voltage battery warning
    - Non-programming warnings
    - Program missing warning
    - DC (DC) detection warning
    - Low potential warning
    - Overload demand warning
    - Reactive power advance warning
    - Active reverse warning
    - Running error detection.
- 6 ) Remote circuit breaker: (omitted)
- 7 ) Key components in the I- -210 + C meter
  - Measurement chip
    - 32 bit CE
    - 8 bit MPU
    - 16 k Byte ROM---Code
    - 2 k Byte RAM
  - microcontroller
    - 256 k Flash ROM
    - 12 k RAM
  - EEPROM:; Data and program parameters
    - 256 k bit
  - Crystal vibration 32 kHz: timing

#### 4. What are the differences between ANSI (C12) electricity meter standard and IEC standard?

A summary of this section was reported online on April 15,2010: "ANSI and IEC electrical metering standards are not the same"

1) The most obvious difference between the general ANSI instrument and the general IEC instrument is that the ANSI instrument is

garden-shaped and can be inserted into the socket, while the IEC instrument is rectangular, and the junction box is designed to accept the striped wires. These patterns were developed in the early 20th century and are mainly used for indoor (or protective cover) and ANSI instruments are mainly used for outdoor influence. Because ANSI instruments are used outdoors, they have a wider working temperature range and provide better climate protection. However, it must be noted that the ANSI standard also determines the socket instrument style (junction boxes designed with striped wires) and the IEC standard has a complete set of expanded temperature ranges for outdoor instruments.

2) There are many similarities between the two sets of standards. Since the IEC and ANSI instruments have the same main functions, both sets of standards specify many of the same tests. They all stipulate the accuracy of starting current, latent current, a series of load current, voltage and power factor, and stipulate the absence from external influences such as voltage surge, current surge, magnetic field, electrostatic discharge and radio interference. However, there are differences in the test grade and test conditions.

3) The IEC and ANSI instruments are not tested under exactly the same conditions. Both sets of standards apply to the frequencies of 50Hz and 60Hz.

— The ANSI standard fully defines the size and shape of external wiring for socket instruments (the S base) and junction box instruments (the A base). An important aspect of the IEC standard omitted is the junction box size.

— ANSI and IEC measures (two important differences of):

· The first one is the method to determine the current rating value. The ANSI standard determines a few maximum current values (such as 200A or 10A), the performance requirements for all other loads are based on this classification, and the calibration point in ANSI is called test Abe (TA). Instead, IEC standards use midscale calibration points as a basis for other performance requirements. The term "basic current (I<sub>b</sub>)" is used for directly connected IEC meters, and the term "rated current (I<sub>n</sub>)" is used for

instruments connected by transformers. In IEC instruments, the maximum current is different from the basic current or the rated current.

· The second important fact is the use of the term "rank". In the ANSI standard, the grade is the maximum current rating of the instrument, such as the maximum current rating of a grade ANSI 20 instrument is 20A. In the IEC standard, the term "grade" refers to the accuracy specification, for example, the basic accuracy rating of the level IEC 2 level instrument is 2%.

#### 4) Agreement standards

There is a partial compatibility between the ANSI and the IEC communication standards. The recently released IEC protocol standards enable the use of the ANSI C12.19 charts. For safety importance reasons, the ANSI and IEC instruments use light channels through the housing. The physical spacing and the optical signals are the same in the ANSI and IEC measurement standards. But the optical transmitter and the receiver are the opposite. Magnetism and the mechanisms are also different. Despite these differences, it is possible to manufacture optical plugs and adapters for any type of instrument.

### 5. The joint venture project of State Grid and GE smart meter is shifting in progress

This article below describes the process of state Grid: GE Smart Meter joint venture project after July 1, 2009.

1) On August 10, 2009, the author of this article and senior experts of Luneng Group went to Beijing State Grid Communication Company to discuss the communication requirements of smart meters. Experts from Chinese Electricity Research Institute were absent for some reason.

2) On August 18, 2009, State Grid Corporation of China released the 2009 version of state Grid smart meter series enterprise standard for the first time.

3) It is estimated that in the fourth quarter of 2009, Luneng Group Company, China Electric Power Research Institute and GE Company formed a joint venture of Shandong Electronics Company to produce Luneng brand smart electricity meters. Among them, Luneng Group company holdings, China Electric

Research Institute is responsible for the technology, GE company as the investor. So far, the author of this article no longer serves as the general technical consultant of Luneng Fang.

4) On June 2, 2010, Shandong Electronics Company held a discussion on luneng smart meter design outline in Beijing. The author of this article was invited to attend the meeting.

At the meeting, experts from China Electric Power Research Institute introduced the 2009 version of the state Grid smart meter series enterprise standard and will be converted into the Luneng smart meter design outline.

5) On July 20, 2010, Shandong Electronics Company held a meeting on Luneng smart electricity meter process design and key equipment selection in Jinan. The author of this article was invited to attend the meeting.

6) On October 20, 2010, Shandong Electronics Company held a discussion on luneng smart electricity meter technology scheme in Jinan. The author of this article was invited to attend the meeting.

at the meeting:

- A company in Nanjing introduced the design scheme of single-phase smart electricity meters
- A company in Changsha introduced the design scheme of three-phase smart electricity meters
- This meeting only discussed, but did not put forward the luneng smart electricity meter technology scheme.

7) On February 20, 2011, Shandong Electronics Company held the Luneng smart electricity meter production process equipment review meeting in Jinan.

- Delegates present:

· Evaluation experts: 12 experts from Shandong Metrology Institute, Weisheng, Linyang and Zhengzhou Sida Company. The author of this article was invited to attend the meeting.

· 12 leaders and experts of Shandong Electronics Company

- At the meeting, a special report was delivered by a design institute in Hangzhou:

· Description of the process scheme of the smart

electricity meter construction project

· Process scheme evaluation report of Shandong Electronics Company.

8) On March 8, 2011, Shandong Electronics Company held the first phase bidding meeting of single-phase smart meter production line in Jinan. The author of this article is invited to attend the bid evaluation.

Bidder: 5 (Henan Star, Zhengzhou Three Anhui, Haiyan Hanpu, Nanjing Automation Factory No.3, Haiyan Company).

9) On April 26, 2011, Shandong Electronics Company held the bidding meeting of the second phase of the single-phase intelligent electric power production line equipment in Jinan. The author of this article is invited to attend the bid evaluation.

Tenderers: 7 (Nanjing Automation Factory No.3, Shanghai Sichuan, Haiyan Shengdi, Zhengzhou Sihui, China, Henan Star, Hangzhou Houda, Haiyan Xinyue).

10) On March 9, 2012, the author met with GE experts of Shandong Electronics Company in Jinan to discuss the performance evaluation method of three-phase electricity meters at the KV2c pass of GE Company.

—GE specialist

· Shandong Electronics Company plans to introduce the 0.5S class three-phase electricity meter scheme of domestic XX Company, embed the characteristic technology of GE KV2c-type three-phase electricity meter, develop it into a 0.2S class three-phase electricity meter, and enter the state grid centralized bidding of 0.2S class electricity meter.

· It is required to develop smart meters according to the standards of state Grid smart Meter series, with a long cycle and too much cost.

-The author of this article

· Weisheng has developed a three-phase electricity meter of 0.1S pass, which is developed according to the requirements of the main meter metering. This time, Shandong electronics company high-end three-phase electricity meter development plan positioning, needs to be carefully considered.

· In China, the performance test and evaluation of

GE KV2c three-phase electricity meter can be entrusted to Chongqing Institute of Electricity Science, which has many years of experience in pass meter testing. The author of this article may provide assistance, if required.

—GE specialist

The company's stake in Shandong Electronics may be withdrawn, and the leaders and experts working for the company will all return to Beijing.

11) It is estimated that in 2013, according to the unified adjustment plan of state Grid institutions, Shandong Electronics Corporation will be fully taken over by State Grid Xuji Group Corporation. At this point, state Grid: GE smart meter joint venture project announced the end.

## 6. Summary

1 ) Speech at the State Grid: GE Smart Meter Technology Exchange Conference on July 1, 2009:

- In 1996, Shandong Power Grid imported the American GE Company 0.2 class KV three-phase electronic electricity meters in batches. Now (in 2009), it is still operating and measuring on the power grid.

In March 1997, the author went to the electricity meter factory of GE Company to study and train with the visiting delegation of Shandong Electric Power Company. It can be said that Shandong power grid has an early understanding of GE KV-type electricity meters. This time, the GE brought AC KV2c meter is a new meter developed based on the KV meter.

- After 20 years of development, China's electronic electricity meter has established a complete system of electronic electricity meters products ranging from grade 2 to grade 0.2S level. However, compared with the international Langier, GE and other brand electricity meters, there are still many differences between domestic electricity meters, which need to introduce advanced technology, expand and deepen the development.

- Here, the author expects to present the following meter design and application issues to communicate with GE experts:

· The intelligent meaning of the GE smart electricity meter

· Active power measurement algorithm

· Is the measurement error calibrated if the power factor is 0.01?

· Harmonic reactive power metering algorithm

· China has not yet established a system of reactive power measurement value transmission. Is the system already built in the United States?

· What are GE's topics for the development of IEEE1459 standard application?

· Local communication of KV2c electricity meter adopts WiMax wireless communication. It is understood that IEEE and Home Plug alliance have issued many broadband power line carrier communication standards, the local communication of KV2c meters why not use broadband carrier communication?

At the meeting, GE experts said: after the above questions, GE electricity meter design experts need to reply.

2 ) In 2009, State Grid: GE Smart meter joint venture project turned in advance:

- Compared with the 2009 version of State Grid smart meter, GE smart meter has many features, mainly including:

· Wide working range of voltage and convenient application

· Maximum current range to 320 / 200A. Adopt plug-in structure, high processing accuracy, access without power failure.

· Garden-shaped shell, outdoor use, high-temperature resistance

· High accuracy, single-phase electric meter with 0.2 / 0.5 level

· Sinusoidal electric energy measurement functions and many voltage measurement functions

· Load curve storage container is large

· Metering chip, with 2 pieces: 32 bit CE, 8 bit MPU

· Recharging ultracapacitor, power outage and backup power supply

· High-speed two-way communication, which can be used as an Internet router

- Compared with the 2009 version of State Grid smart meters, the shortcomings of GE smart meters:

· Prepayment, there is no reference standard yet

· More professional application functions and few functions

· The table pricing level is higher

- -Therefore, the GE smart meter in 2009, measured by comprehensive performance, is not suitable for the multi-functional and low-cost demand of the state grid electricity information collection system, which can be clearly explained.

It should be pointed out here that:

· State Grid, 2013 version of state Grid standard smart meter, single-phase meters have only active power metering, no reactive power and visible grid metering; three-phase meters are not visible metering. This measurement method is not complete and does not meet the needs of high-quality intelligent distribution network construction in the future.

· Through the implementation of state Grid: GE smart electricity meter joint venture project, the understanding of ANSI standards is deepened, which is conducive to the design improvement and export of domestic electricity meters.

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